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DIODE

STEP STRESS TESTING PROGRAM

MSFC/NASA CONTRACT NUMBER
NAS8-31944

FINAL REPORT
FOR

JANTX 1N5618

FEBRUARY 1979

Prepared
For

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FOREWORD

This report is a summary of the work performed on NASA Contract NAS8-31944. The investigation was conducted for the National Aeronautics and Space Administration, George C. Marshall Space Flight Center, Huntsville, Alabama. The Contracting Officer's Technical Representative was Mr. F. Villella.

The short-term objective of this preliminary study of transisters, diodes, and FETS is to evaluate the reliability of these discrete devices, from different manufacturers, when subjected to power and temperature step stress tests.

The long-term objective is to gain more knowledge of accelerated stress testing for use in future testing of discrete devices, as well as to determine which type of stress should be applied to a particular device or design.

This report is divided as follows: description of tests, figures, tables, and appendix.

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1.0 INTRODUCTION

DCA Reliability Laboratory, under Contract NAS8-31944 for NASA/Marshall Space Flight Center, has compiled data for the purpose of evaluating the effect of power/temperature step stress when applied to a variety of semiconductor devices. This report covers the switching diode JANTX1N5618 manufactured by SEMTECH and MICRO SEMICONDUCTOR.

A total of 48 samples from each manufacturer were submitted to the process outlined in Table 1. In addition, two control sample units were maintained for verification of the electrical parametric testing.

2.0 TEST REQUIREMENTS

2.1 Electrical

All test samples were subjected to the electrical tests outlined in Table 2 after completing the prior power/temperature step stress point. These tests were performed using the Fairchild Model 600 High-Speed Computer-Controlled Tester. Additional bench testing was also required on the devices.

2.2 Stress Circuit

The test circuit shown in Figure 1 was used to power all the test devices during the power/temperature stress conditions. The voltage was set by V_F and the current was varied in order to comply with the specified power rating for the device. At least one of the devices was subjected to maximum rated power (MRP). All remaining devices were

subjected to no less than 90% of MRP. See Figure 1 for load resistance values and voltages.

2.3 Group I - Power Stress

Thirty-two units, 16 from each manufacturer, were submitted to the Power Stress Process. The diodes were stressed in 500-hour steps at 50, 100, 125, 150 and 175 percent of maximum rated power (MRP) for 2500 hours or until 50% or more of the devices in a sample lot failed.* Electrical measurements were performed on all specified electrical parameters after each power step. See Table 1. (*See Notes at end of text.)

2.4 Group II - Temperature Stress I

Thirty-two units, 16 from each manufacturer, were submitted to the Temperature Stress I Process. Group II was subjected to 1600 hours of stress at maximum rated power in increments of 160 hours. The temperature was increased in steps of 25°C, commencing at 75°C and terminating at 300°C or until 50% or more of the devices failed.* Electrical measurements were performed on all specified electrical parameters after each temperature step. See Table 1.

2.5 Group III - Temperature Stress II

Thirty-two units, 16 from each manufacturer, were submitted to the Temperature Stress II Process. Group III was subjected to 112 hours of stress at maximum rated power in increments of 16 hours. The temperature was increased in steps of 25°C, commencing at 150°C and terminating at 300°C or until 50% or more of the devices in a sample lot

failed.* Electrical measurements were performed on all specified electrical parameters after each temperature step. See Table 1.

3.0 DISCUSSION OF TEST RESULTS

3.1 Group I - Power Stress

3.1.1 Semtech. The Semtech sample lot completed the entire 2500 hours of Group I Testing with no catastrophic failures. Typical characteristics of this sample lot's performance were:

1) The mean value for I_R changed 105.6nA from an initial mean of 43.90nA to a final mean of 149.5nA.
2) The mean value for V_F changed 18.00mV from an initial mean of 1.096V to a final mean of 1.114V.

The control units for this sample lot remained constant throughout the entire Group I Testing.

3.1.2 Micro Semiconductor. The Micro Semiconductor sample lot completed 2150 hours of Group I Testing before being stopped because of a failure rate exceeding 50% of the lot. The first failure occurred 500 hours into the 125% MRP step. Serial number 6339 failed due to excessive I_R leakage. The next failures occurred 10 hours into the 150% MRP step. Serial numbers 6344 and 6347 failed due to excessive I_R leakage. The next failure occurred 50 hours into the 150% MRP step. Serial number 6336 failed due to excessive I_R leakage. The next failures occurred 150 hours into the 150% MRP step. Serial numbers 6341 and 6342 failed due to

excessive I_R leakage. The last failures occurred 150 hours into the 175% MRP step. Serial numbers 6333, 6337, 6338 and 6348 were all visual catastrophic failures. (See Note B on Table 8). Typical characteristics of this sample lot's performance were:

1) The mean value for I_R changed 70.33nA from an initial mean of 33.27nA to a final mean of 103.6nA.
2) The mean value for V_F changed 26.00mV from an initial mean of 1.067V to a final mean of 1.093V.

The control units for this sample lot remained constant throughout the entire Group I Testing.

3.1.3 Statistical Summary - Group I. Table 4 outlines the results of Group I - Power Stress Process for each of the electrical parameters and all measurement points for both Semtech and Micro Semiconductor.

3.2 Group II - Temperature Stress I

3.2.1 Semtech. The Semtech sample lot completed the entire 1600 hours of Group II Testing with one catastrophic failure. The failure occurred 160 hours into the 300°-C temperature step. Serial number 6316 was a visual catastrophic failure. (See Note C on Table 8). At this point, serial number 6286 was removed as a visual reject due to handling. Typical characteristics of this sample lot's performance were:

1) The mean value for I_R changed 164.4nA from an initial mean of 61.79nA to

a final mean of 226.2nA.

2) The mean value for V_F changed 9.000mV from an initial mean of 1.085V to a final mean of 1.094V.

The control units for this sample lot remained constant throughout the entire Group II Testing.

3.2.2 Micro Semiconductor. The Micro Semiconductor sample lot completed a total of 800 hours of Group II Testing before the lot was stopped because 50% of the devices failed. The lot continued processing another 160 hours and had four more catastrophic failures. The first failures occurred 160 hours into the 125°-C temperature step. Serial number 6359 was removed as a visual catastrophic failure. (See Note B on Table 8). Serial numbers 6363 and 6364 failed due to excessive I_R leakage. The next failures occurred 160 hours into the 150°-C temperature step. Serial number 6353 failed due to excessive I_R leakage. Serial number 6362 was removed as a visual catastrophic failure. (See Note B on Table 8). The next failuures occurred 160 hours into the 175°-C temperature step. Serial numbers 6352 and 6361 were removed as visual catastrophic failures. (See Note B on Table 8). The last failures occurred 160 hours into the 400°-C temperature step. Serial numbers 6355, 6357, 6358 and 6360 were removed as visual catastrophic failures. Typical characteristics of this sample lot's performance were:

1) The mean value for I_R changed 293.6nA from an initial mean of 20.74nA to a final mean of 314.3nA.

2) The mean value for V_F changed 17.00mV

from an initial mean of 1.081V to a final mean of 1.098V.

The control units for this sample lot remained constant throughout the entire Group II Testing.

3.2.3 Statistical Summary - Group II. Table 5 of this report outlines the results of Group II - Temperature Stress I Testing, for each of the electrical parameters and all of the measurement points pertaining to both Semtech and Micro Semiconductor.

3.3 Group III - Temperature Stress II

3.3.1 Semtech. The Semtech sample lot completed the entire 112 hours of Group III Testing with no catastrophic failures. Typical characteristics of this sample lot's performance were:

1) The mean value for I_R changed 33.01nA from an initial mean of 77.19nA to a final mean of 110.2nA.

2) The mean value for V_F changed 13.00mV from an initial mean of 1.112V to a final mean of 1.125V.

The control units for this sample lot remained constant throughout the entire Group III Testing.

3.3.2 Micro Semiconductor. The Micro Semiconductor sample lot completed the entire 112-hour Group III Testing with a total of seven catastrophic failures. The first failure occurred 16 hours into the 275°C-temperature step. Serial numbers 6332, 6365, and 6369 failed due to excessive I_R leakage. The last failures occurred 16 hours into the

300°C-temperature step. Serial numbers 6367, 6372, 6376 and 6378 failed due to excessive I_R leakage. Serial number 6373 was missing from the testing at 16 hours into the 150°C-temperature step. Typical characteristics of this sample lot's performance were:

1) The mean value for I_R changed 202.3μA from an initial mean of 17.52nA to a final mean of 202.3μA.
2) The mean value for V_F changed 4.000mV from an initial mean of 1.065V to a final mean of 1.069V.

The control units for this sample lot remained constant throughout the entire Group III Testing.

3.3.3 Statistical Summary - Group III. Table 6 outlines the results of Group III - Temperature Stress II Testing, for each of the electrical parameters and all of the measurement points for both Semtech and Micro Semiconductor.

4.0 FINAL DATA SUMMARY

Table 7 statistically summarizes the change in the mean value from the zero-hour data to the final data. The graphs of Figures 2 and 4 plot the cumulative percent failures versus the temperature stress level for Group II - Temperature Stress I, and Group III - Temperature Stress II. The graphs of Figures 3 and 5 plot the time step for Group II (160 hours) and Group III (16 hours) versus the temperatures T_1 and T_2 calculated from Figures 2 and 4. Tables 8 and 9 summarize the failures encountered for all three stress groups. The failures are separated into two categories:

catastrophic failures in Table 8 and parametric failures in Table 9. The data from Table 8 were used as a source for the graphs in Figures 2 and 4. Figures 2 and 4 were used as a source for the graphs in Fig. 3 & 5, respectively. Junction temperature is plotted on an inverse hyperbolic scale.

5.0 CONCLUSIONS

In each of the three tests groups, the Semtech diodes proved to be sturdier than those of Micro Semiconductor. The Semtech sample lots successfully completed all three testings with only one catastrophic failure. The Micro Semiconductor Group I and II lots were stopped and the Group III lot had several failures. Since the Semtech sample lots performed so well, only the Micro Semiconductor lots were submitted to failure analysis. One major failure mode was the connecting metal melting causing the external lead to open. The analyzed dice were still within acceptable test limits, but their reliability has been impaired by cracked glass. The other failure mode was excessive I_R leakage. Failure analysis revealed that the die and its glass were fractured due to the high junction temperatures reached in the testing.

A graph showing the cumulative failure distribution for Groups II and III was drawn for the Micro Semiconductor sample lot (Figures 4 and 5). However, since there were no non-visual catastrophic failures for the Siemens sample lot, no points could be plotted (Figures 2 and 3). Figures

4 and 5 display the data used to calculate an activation energy of .74eV for Micro Semiconductor.

A broken circle around a marked point on the graph indicates a freak failure not calculated as part of the regression line. A solid circle around a marked point indicates an isolated main failure point. The regression line was calculated using the least squares method.

Because of visual defects caused by the extreme heat of the stress tests, serial numbers 6332, 6353, 6365 and 6369 were not calculated as part of the regression line.

The activation energy was calculated from the formula:

$$E = \left[\ell n \left(\frac{t_1}{t_2} \right) \right] \left[\frac{8.63 \times 10^{-5} \text{ eV}/^{\circ}\text{K}}{\left(\frac{1}{T_1+273} \right) - \left(\frac{1}{T_2+273} \right)} \right] \text{eV}$$

Where: t_1 = step of Group II - Temp Stress I = 160 hrs.

t_2 = step of Group III - Temp Stress II = 16 hrs.

T_1 = temperature in $^{\circ}$C of 16% failure for Group II.

T_2 = temperature in $^{\circ}$C of 16% failure for Group III.

NOTE:

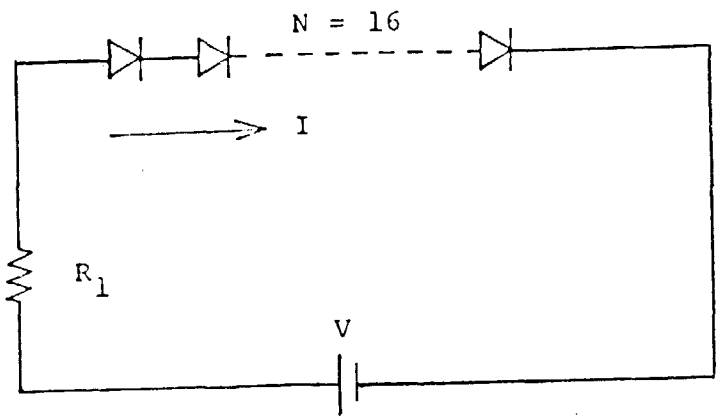
* Conditions for failure:

A) Open or short

B) Leakage exceeds the maximum limit by 100 times

C) Other parameters exceed MIL limits by 50% or more.

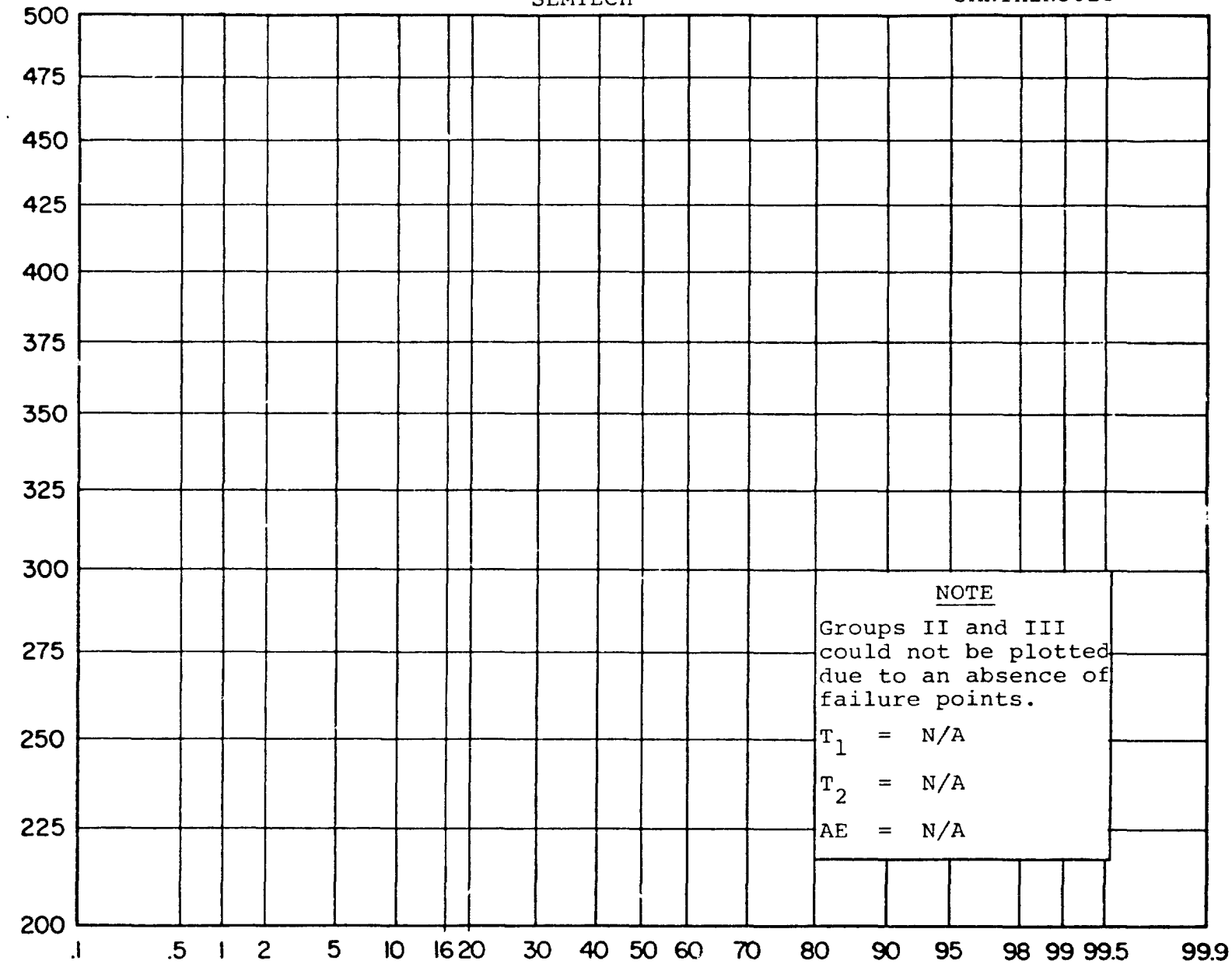
SWITCHING DIODES



$R_1 = 1V/_I \pm 1\%$

$P_d = IE$

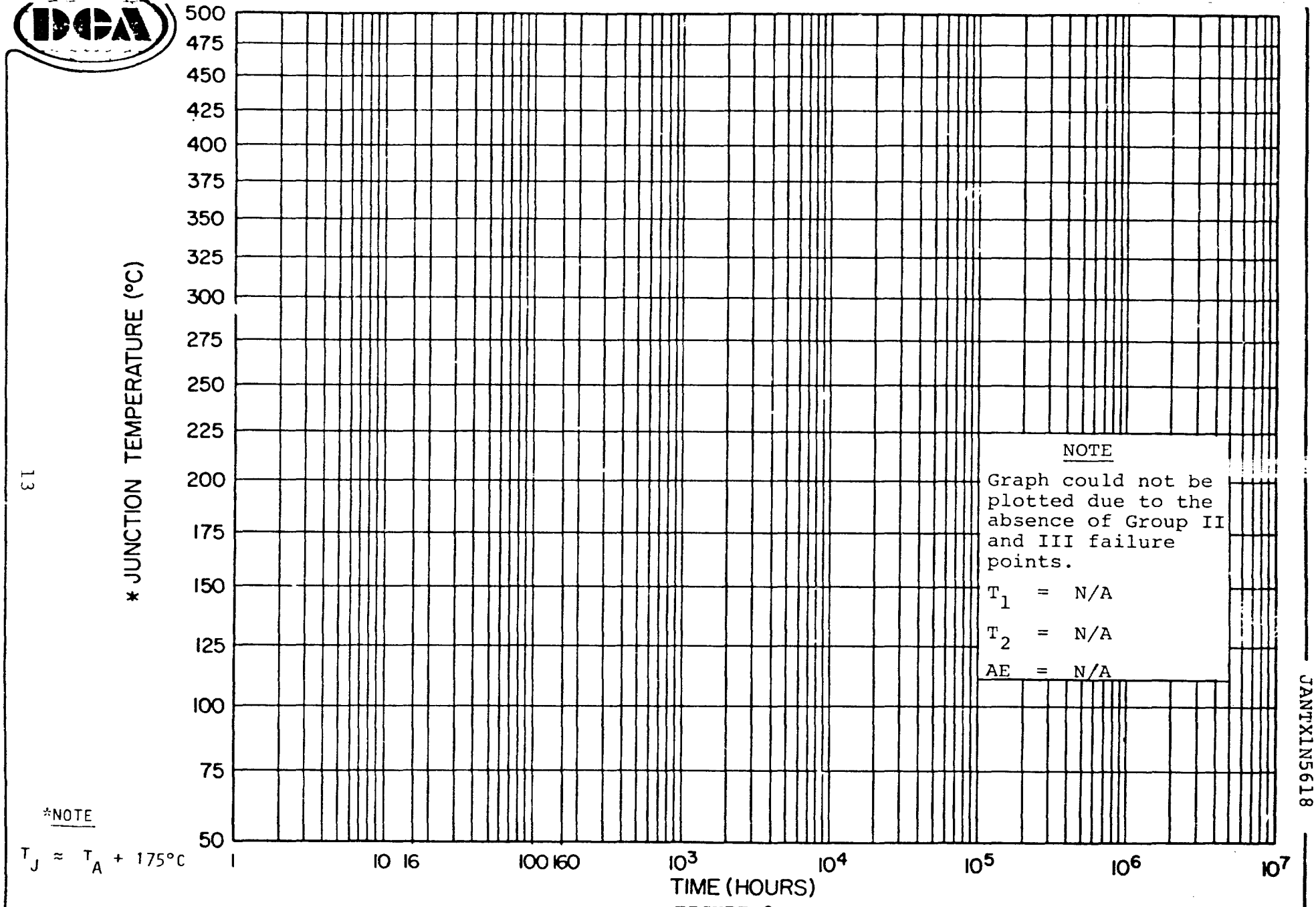
FIGURE 1
Power/Stress Circuit
for JANTX1N5618



*NOTE

$T_J \approx T_A + 175°C$

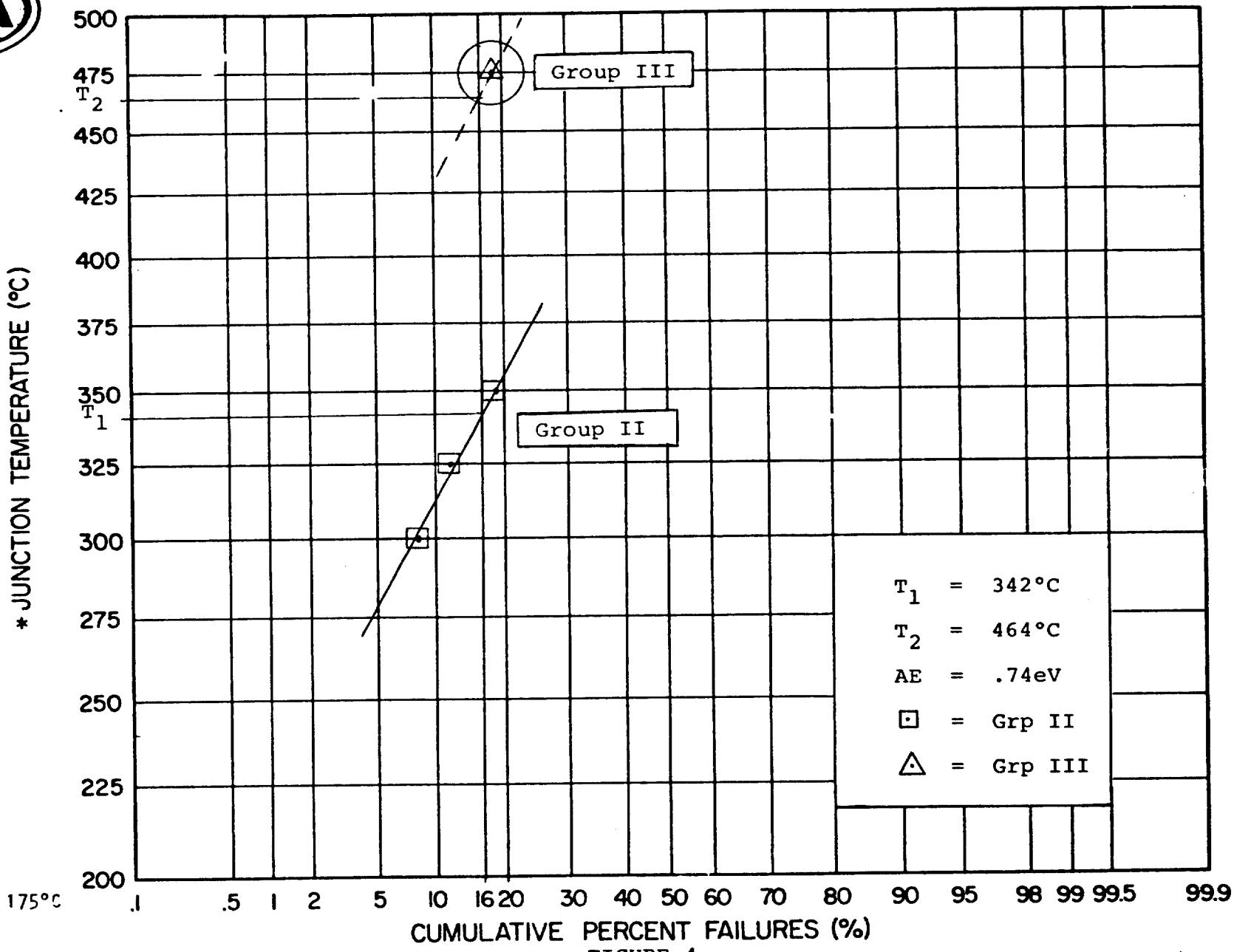
FIGURE 2
Cumulative Percent Failures Versus Junction Temperature, Semtech



*NOTE

$T_J \approx T_A + 175°C$

FIGURE 3
Time Steps Versus Junction Temperature, Semtech

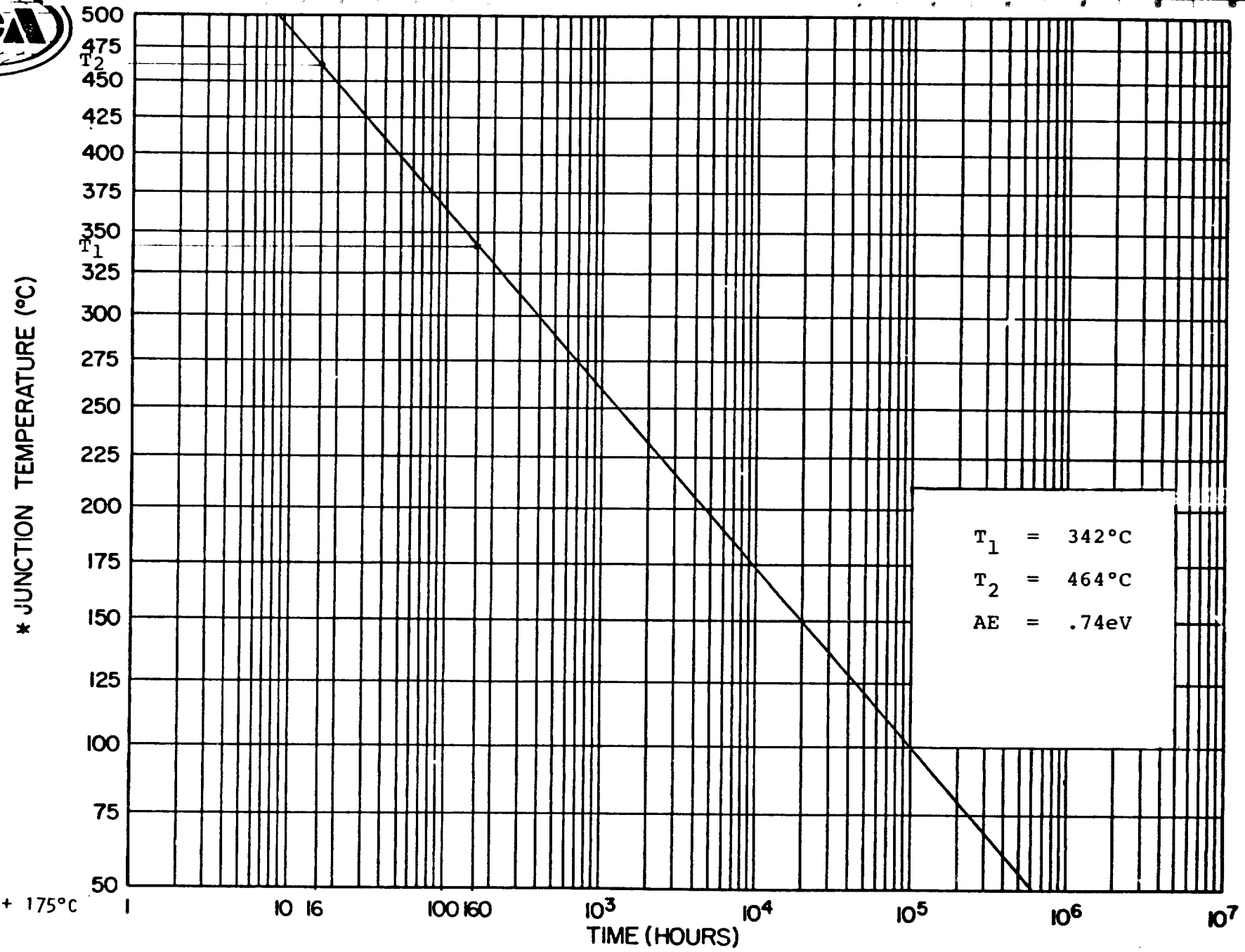


*NOTE

$T_J \approx T_A + 175°C$

FIGURE 4

Cumulative Percent Failures Versus Junction Temperature, Micro Semiconductor



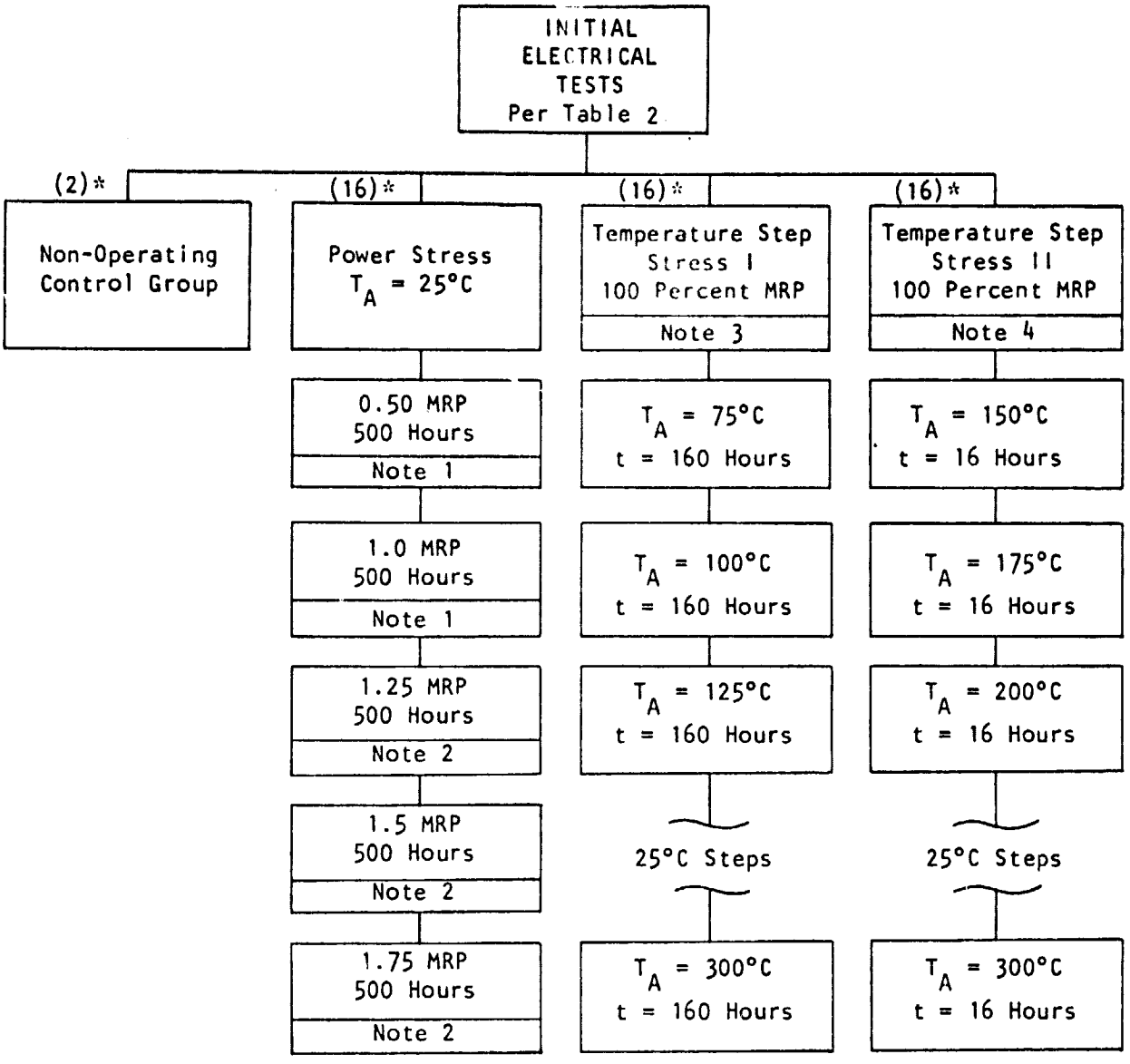
*NOTE

$T_J \approx T_A + 175°C$

FIGURE 5

Time Steps Versus Junction Temperature, Micro Semiconductor

TABLE 1
TEST FLOW DIAGRAM



*Quantity per manufacturer (Semtech and Micro Semiconductor)

NOTES:

1) Electrical measurements per Table 2 were made at 50, 150, 250 and 500 hours.
2) Electrical measurements per Table 2 were made at 10, 25, 50, 150, 250 and 500 hours.
3) Electrical measurements per Table 2 were made at the end of each 160 hours.
4) Electrical measurements per Table 2 were made at the end of each 16 hours.

TABLE 2
PARAMETERS AND TEST CONDITIONS

PARAMETER	CONDITIONS	SPEC. LIMIT		CAT. LIMIT		UNITS
		MIN	MAX	MIN	MAX	
I_R	V_R = 600V	-	.5	-	50	µA
V_F	I_F = 3.0A (Pulsed)	0.8	1.3	0.4	1.95	V(PK)

NOTES:
1/ In addition, any open or short shall be considered catastrophic

TABLE 3
POWER STRESS BURN-IN CONDITIONS

V_F = 1V	
I_F	Percent P_D
0.6 A	50
1.2A	100
1.5A	125
1.8A	150
2.1A	175

NOTE
FOR TABLES
4 THROUGH 7

The minimum/maximum initial and final data generally have an absolute accuracy of ±1% of the reading and ± one digit except for readings greater than 9.99mA which have an absolute accuracy of ±2% of the reading and ± one digit. The data also have a resolution for four digits. The standard deviations, means, delta means, and average means are, therefore, valid indicators of trends over time and temperature, excepting the minor statistical computer error of supplying a constant number of significant digits.

TABLE 4
GROUP I – POWER STRESS DATA SUMMARY

PARAMETER	I_R = .5μA (MAX)		V_F=.8V(MIN)(PK) 1.3V(MAX)(PL)					
CONDITIONS AND LIMIT	@ V_R = 600V		I_F = 3.0A (Pulsed)					
IDENTIFICATION	SEM	MSC	SEM	MSC				
INITIAL DATA								
MIN VALUE	11.60nA	3.230nA	1.030V	1.040V				
MAX VALUE	102.0nA	247.0nA	1.240V	1.140V				
MEAN	43.90nA	33.27nA	1.096V	1.067V				
STD DEV	32.12nA	72.47nA	61.33mV	27.55mV				
INTERIM DATA								
POWER 50 TO 125% Δ MEAN VALUE								
50% POWER								
50 HRS	3.210nA	480.0pA	1.000mV	1.000mV				
150 HRS	6.630nA	1.000nA	9.000mV	8.000mV				
250 HRS	8.490nA	540.0pA	10.00mV	9.000mV				
500 HRS	4.420nA	-370.0pA	13.00mV	9.000mV				
100% POWER								
550 HRS	10.98nA	5.500nA	-12.00mV	-10.00mV				
650 HRS	3.980nA	1.400nA	17.00mV	10.00mV				
750 HRS	1.360nA	10.32nA	20.00mV	16.00mV				
1000 HRS	2.060nA	9.940nA	18.00mV	11.00mV				
125% POWER								
1010 HRS	4.290nA	8.700nA	10.00mV	0.000V				
1025 HRS	3.410nA	12.40nA	20.00mV	14.00mV				
1050 HRS	1.090nA	13.09nA	15.00mV	7.000mV				
1150 HRS	4.430nA	14.29nA	9.000mV	3.000mV				
1250 HRS	2.550nA	9.070nA	-17.00mV	-32.00mV				
1500 HRS	9.970nA	*4.688μA	18.00mV	8.000mV				

(continued on second sheet)

TABLE 4 (Cont'd)
GROUP I — POWER STRESS DATA SUMMARY

(continued from first sheet)

PARAMETER	I_R = .5μA(MAX)		V_F = .8V(MIN)(PK) 1.3V(MAX)(PK)					
CONDITIONS AND LIMITS	V_R = 600V		I_R = 3.0A (Pulsed)					
IDENTIFICATION	SEM	MSC	SEM	MSC				
INITIAL DATA								
MIN VALUE	11.60nA	323.0nA	1.030V	1.040V				
MAX VALUE	102.0nA	247.0nA	1.240V	1.140V				
MEAN	43.90nA	33.27nA	1.096V	1.067V				
STD DEV	32.12nA	72.47nA	61.33mV	27.55mV				
INTERIM DATA								
POWER 150 TO 175% Δ MEAN VALUE								
150% POWER								
1510 HRS	43.51nA	*278.7μA	26.00mV	14.00mV				
1525 HRS	12.27nA	713.6μA	24.00mV	11.00mV				
1550 HRS	20.04nA	*77.72μA	20.00mV	9.000mV				
1650 HRS	9.390nA	*420.0μA	9.000mV	8.000mV				
1750 HRS	15.12nA	32.47nA	25.00mV	13.00mV				
2000 HRS	20.92nA	30.50nA	26.00mV	14.00mV				
175% POWER								
2010 HRS	25.82nA	35.01nA	27.00mV	15.00mV				
2025 HRS	31.13nA	32.51nA	23.00mV	14.00mV				
2050 HRS	31.02nA	98.53nA	23.00mV	12.00mV				
2150 HRS	34.84nA	70.33nA	26.00mV	26.00mV				
2250 HRS	41.35nA	JOB STOPPED	30.00mV	JOB STOPPED				
2500 HRS	105.6nA	↓ ↓	18.00mV	↓ ↓				
FINAL DATA								
MIN VALUE	31.60nA	7.000nA	1.030V	1.060V				
MAX VALUE	599.0nA	396.0nA	1.270V	1.160V				
MEAN	149.5nA	103.6nA	1.114V	1.093V				
STD DEV	146.0nA	146.6nA	65.86mV	33.99mV				

* NOTE: Catastrophic reject(s) removed from data after this point.

TABLE 5

GROUP II TEMP STRESS I DATA SUMMARY

PARAMETERS	I_R = .5μA(MAX)		V_F = .8V(MIN)(PK) 1.3V(MAX)(PK)					
CONDITIONS AND LIMITS	V_R = 600V		I_F = 3.0A (Pulsed)					
IDENTIFICATION	SEM	MSC	SEM	MSC				
INITIAL DATA								
MIN VALUE	7.210nA	1.790nA	999.0mV	1.050V				
MAX VALUE	190.0nA	112.0nA	1.200V	1.180V				
MEAN	61.79nA	20.74nA	1.085V	1.081V				
STD DEV	49.39nA	32.99nA	52.64mV	35.33mV				
INTERIM DATA (INITIAL TO FINAL)								
Δ MEAN VALUE								
TOTAL HRS / TEMP (T_A)								
160 / 75°C	-4.000nA	2.940nA	6.000mV	7.000mV				
320 / 100°C	-2.300nA	1.190nA	9.000mV	10.00mV				
480 / 125°C	9.250nA	*78.54μA	10.00mV	10.00mV				
640 / 150°C	5.670nA	*28.75μA	12.00mV	19.00mV				
800 / 175°C	13.63nA	*28.78μA	10.00mV	21.00mV				
960 / 200°C	5.590nA	293.6nA	10.00mV	17.00mV				
1120 / 225°C	545.4nA	JOB STOPPED	13.00mV	JOB STOPPED				
1280 / 250°C	277.7nA	↓ ↓	14.00mV	↓ ↓				
1440 / 275°C	75.81nA		2.000mV					
1600 / 300°C	164.4nA		9.000mV					
FINAL DATA								
FINAL TEMP (T_A)	300°C	200°C	300°C	200°C				
MIN VALUE	24.40nA	2.970nA	999.0mV	1.070V				
MAX VALUE	999.0nA	1.100μA	1.200V	1.190V				
MEAN	226.2nA	314.3nA	1.094V	1.098V				
STD DEV	237.4nA	428.9nA	48.41mV	46.22mV				

* NOTE: Catastrophic reject(s) removed from data after this point

TABLE 6

GROUP III TEMP STRESS II DATA SUMMARY

PARAMETERS	I_R = .5μA (MAX)		V_F = .8V(MIN)(PK) 1.3V(MAX)(PK)					
CONDITIONS AND LIMITS	V_R = 600V		I_F = 3.0A (Pulsed)					
IDENTIFICATION	SEM	MSC	SEM	MSC				
INITIAL DATA								
MIN VALUE	9.270nA	1.930nA	999.0mV	1.040V				
MAX VALUE	194.0nA	183.0nA	1.230V	1.120V				
MEAN	77.19nA	17.52nA	1.112V	1.065V				
STD DEV	60.15nA	43.39nA	53.81mV	22.08mV				
INTERIM DATA (INITIAL TO FINAL)								
Δ MEAN VALUE								
TOTAL HRS. TEMP(T_A)								
16 150°C	1.830nA	2.350nA	7.000mV	3.000mV				
32 175°C	10.54nA	3.160nA	5.000mV	4.000mV				
48 200°C	9.480nA	3.290nA	7.000mV	2.000mV				
64 225°C	8.860nA	610.0pA	7.000mV	7.000mV				
80 250°C	17.97nA	195.2nA	6.000mV	4.000mV				
96 275°C	14.48nA	*75.09μA	17.00mV	-1.000mV				
112 300°C	33.01nA	*202.3μA	13.00mV	4.000mV				
FINAL DATA								
FINAL TEMP (T_A)	300°C	300°C	300°C	300°C				
MIN VALUE	19.30nA	2.680nA	1.040V	1.040V				
MAX VALUE	452.0nA	1.140mA	1.240V	1.130V				
MEAN	110.2nA	202.3μA	1.125V	1.069V				
STD DEV	103.6nA	373.0μA	49.37mV	25.32mV				

* NOTE: Catastrophic reject(s) removed from data after this point

TABLE 7
FINAL DATA SUMMARY

PARAMETER	SPECIFICATIONS LIMIT		UNITS	MEAN INT. DATA	AVERAGE Δ IN MEAN VALUE					
					POWER STRESS		TEMPERATURE STRESS I		TEMPERATURE STRESS II	
	MIN	MAX			SEM	MSC	SEM	MSC	SEM	MSC
I_R	-	.5	μA		+.01761	*+62.296	+.10912	*+22.728	+.01374	*+39.656
V_F	0.8	1.3	V		+.01569	+.00792	+.00950	+.01400	+.00886	+.00329

* NOTE: Catastrophic reject(s) removed from data

TABLE 8 STEP STRESS CATASTROPHIC FAILURE SUMMARY JAN TX1N5618

GROUP I POWER STRESS

TEST STEP	MFR A		MFR B	
	QTY.	NOTE	QTY.	NOTE
50% 50 hr.	0	–	0	–
100 hr.	0	–	0	–
100 hr.	0	–	0	–
250 hr.	0	–	0	–
100% 50 hr.	0	–	0	–
100 hr.	0	–	0	–
100 hr.	0	–	0	–
250 hr.	0	–	0	–
125% 10 hr.	0	–	0	–
15 hr.	0	–	0	–
25 hr.	0	–	0	–
100 hr.	0	–	0	–
100 hr.	0	–	0	–
250 hr.	0	–	1	A
150% 10 hr.	0	–	2	A
15 hr.	0	–	0	–
25 hr.	0	–	1	A
100 hr.	0	–	2	A
100 hr.	0	–	0	–
250 hr.	0	–	0	–
175% 10 hr.	0	–	0	–
15 hr.	0	–	0	–
25 hr.	0	–	0	–
100 hr.	0	–	4	B
100 hr.	0	–	JOB STOPPED	
250 hr.	0	–	↓	↓

GROUP II 160 HR. TEMP. STEPS

TEST STEP (T_A)	MFR A		MFR B	
	QTY.	NOTE	QTY.	NOTE
75° C	0	–	0	–
100° C	0	–	0	–
125°C	0	–	1 1 1	A D B
150°C	0	–	1 1	A B
175°C	0	–	1 2	A B
200°C	0	–	4	B
225°C	0	–	JOB STOPPED	
250°C	0	–	↓	↓
275°C	0	–		
300°C	1	C		

GROUP III 16 HR. TEMP. STEPS

TEST STEP (T_A)	MFR A		MFR B	
	QTY.	NOTE	QTY.	NOTE
150°C	0	–	0	–
175°C	0	–	0	–
200°C	0	–	0	–
225°C	0	–	0	–
250°C	0	–	0	–
275°C	0	–	3	D
300°C	0	–	3 1	A D

MFR "A" - SEMTECH

MFR "B" - MICRO SEMICONDUCTOR

NOTES: A - I_R > 50μA

B - Visual rejects - external lead disconnected due to stress

C - Visual reject - body split in half due to stress

D - I_R > 50μA and visual reject - cracks in body

TABLE 9 STEP STRESS PARAMETRIC FAILURE SUMMARY JANTX1N5618

GROUP I POWER STRESS

TEST STEP	MFR A		MFR B	
	QTY.	NOTE	QTY.	NOTE
50% 50 hr.	0	–	0	–
100 hr.	0	–	0	–
100 hr.	0	–	0	–
250 hr.	0	–	0	–
100% 50 hr.	0	–	0	–
100 hr.	0	–	0	–
100 hr.	0	–	0	–
250 hr.	0	–	0	–
125% 10 hr.	0	–	0	–
15 hr.	0	–	0	–
25 hr.	0	–	0	–
100 hr.	0	–	0	–
100 hr.	0	–	0	–
250 hr.	0	–	0	–
150% 10 hr.	0	–	0	–
15 hr.	0	–	0	–
25 hr.	0	–	0	–
100 hr.	0	–	0	–
100 hr.	0	–	0	–
250 hr.	0	–	0	–
175% 10 hr.	0	-	0	–
15 hr.	0	–	0	–
25 hr.	0	–	0	–
100 hr.	0	–	0	–
100 hr.	0	–	JOB STOPPED	
250 hr.	1	A	↓	↓

GROUP II 160 HR. TEMP. STEPS

TEST STEP (T_A)	MFR A		MFR B	
	QTY.	NOTE	QTY.	NOTE
75° C	0	–	0	–
100° C	0	–	0	–
125 °C	0	–	0	–
150 °C	0	–	0	–
175 °C	0	–	0	–
200 °C	0	–	0	–
225 °C	1	A	0	–
250 °C	0	–	0	–
275 °C	0	–	0	–
300 °C	1	B	0	–

GROUP III 16 HR. TEMP. STEPS

TEST STEP (T_A)	MFR A		MFR B	
	QTY.	NOTE	QTY.	NOTE
150 °C	0	–	1	C
175 °C	0	–	0	–
200 °C	0	–	0	–
225 °C	0	–	0	–
250 °C	0	–	1	A
275 °C	0	–	0	–
300 °C	0	–	0	–

MFR "A" - SEMTECH

MFR "B" - MICRO SEMICONDUCTOR

NOTES: A - I_R limit failure

B - S/N 6286 removed from testing as visual reject due to handling

C - S/N 6373 missing from testing

APPENDIX A

FAILURE ANALYSIS

POWER STRESS

FAILURE ANALYSIS

Date 29 December 1978

J/N 2CN242-25A **P/N** 1N5618 **MFR** MICRO SEMICONDUCTOR

		End Point: 50μA Max.	End Points: 0.4-1.95 V		
S/N	PIV -volts-	I_R @ 600 V.dc	V_F @ 3.0 A dc	**INITIAL REJ. AT TEST SEQUENCE NO.:**	**INITIAL REJ. FOR:**
6338	1000 (D)	< 100 nA	Can't measure	49 (175% MRP 2150 Hrs.)	Lead off
6347	R = 4.5×10^4	> 50μA	Can't measure	33 (150% MRP 1525 Hrs.)	I_R
6348	950	< 100 nA	Can't measure	49 (175% MRP 2150 Hrs.)	Lead off

VISUAL INSPECTION

S/N 6338 - lead off, cracked glass. S/N 6347 - cracked glass (fell apart). S/N 6348 - lead off. (See Figures A-1 and A-2.)

CONCLUSIONS

S/N 6338 and 6348 Micro Semiconductor diodes failed their power step stress test due to metal melting which caused an external lead to open. S/N 6347 failed when its die and glass were fractured due to the high junction temperatures reached in the testing. Although S/N 6338 has not failed its electrical parameters, its reliability would be impaired by the cracked glass, even if the external lead had not fallen off.

*h_{FE} trace present. Cannot meet stated test conditions. (Leaky)
**h_{FE} trace very leaky.

D=drift H=hysteresis Inv=inversion R=resistive S=soft Uns=unstable

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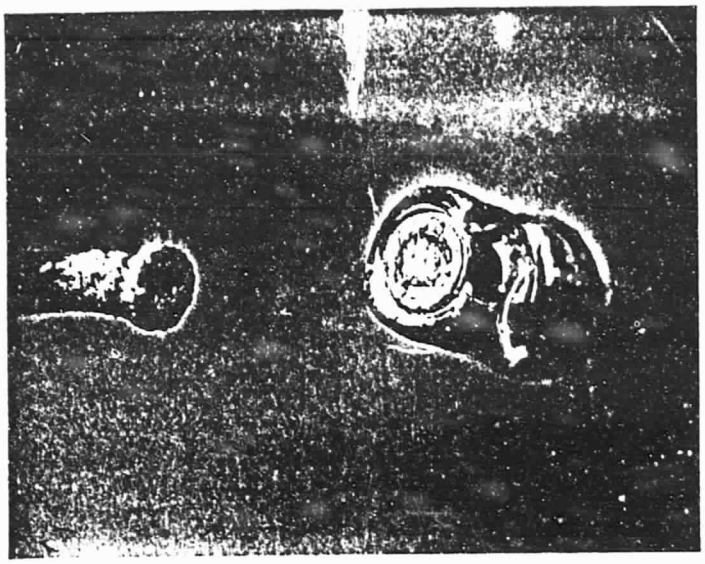

FIGURE A-1
S/N 6338, Micro Semiconductor Diode, 10X.
Typical missing external lead and
cracked glass after power step stress test.

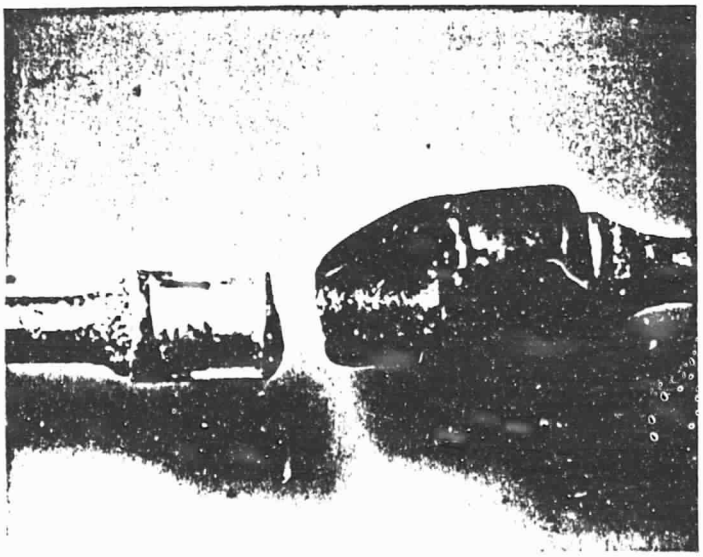

FIGURE A-2
S/N 6347, Micro Semiconductor, 10X.
Destruction of diode due to cracked glass.

APPENDIX B

FAILURE ANALYSIS

TEMPERATURE STRESS

FAILURE ANALYSIS

Date 29 December 1978

J/N 2CN242-25B **P/N** 1N5618 **MFR** MICRO SEMICONDUCTOR

S/N	PIV -volts-	I_{R} @ 600 V.dc	V_{F} @ 3.0 dc	INITIAL REJ. AT TEST SEQUENCE NO.:	INITIAL REJ. FOR:
		End Point: 50μA Max.	End Points: 0.4-1.95 V		
6352	> 1100	< 100 nA	Can't measure	11 (175°C 800 Hrs.)	Lead off
6359	980	< 100 nA	Can't measure	07 (125°C 480 Hrs.)	Lead off
6361 -G	> 1100	< 100 nA	Can't measure	11 (175°C 800 Hrs.)	Lead off

VISUAL INSPECTION

All three Micro Semiconductor samples have lost one external lead. In addition, S/N 6359 and 6361 have cracked glass (see Figures B-1 and B-2).

CONCLUSIONS

These Micro Semiconductor diodes failed the temperature step stress test when their external lead connecting metal melted. The semiconductor dice are still within acceptable test limits, but their reliability has been impaired by the cracked glass.

*h_{FE} trace present. Cannot meet stated test conditions. (Leaky)
**h_{FE} trace very leaky.

D=drift H=hysteresis Inv=inversion R=resistive S=soft Uns=unstable

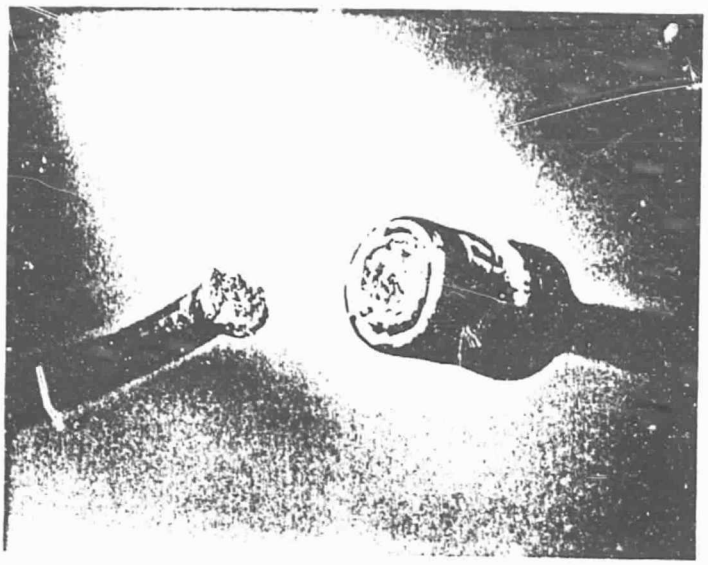

FIGURE B-1
S/N 6352, Typical Missing External Lead
on Micro Semiconductor Diode, 9X.

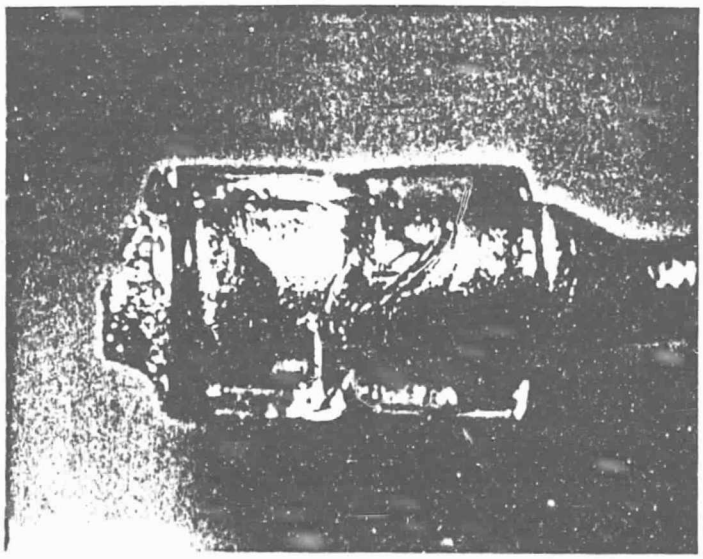

FIGURE B-2
S/N 6338, Typical Cracked Glass on Micro
Semiconductor Diode After Temperature
Step Stress Test, 14X.

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